BACKGROUND AIR PARTICULATE CHEMISTRY IN KUALA LUMPUR

by

Mohd. Rashid Mohd. Yusoff
Department of Chemical Engineering
U.T.M.

Rahmalan Ahmad
Department of Chemistry
U.T.M.

Abdul Khalik Wood
Nuclear Energy Unit
Prime Minister Department

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Mohd. Nashid Mohd. Yusoff
Department of Chemical Engineering,
Universiti Teknologi Malaysia.

Rahmalan Ahmad
Department of Chemistry,
Universiti Teknologi Malaysia.

Abdul Khalik Wood
Nuclear Energy Unit,
Prime Minister Department,
Bangi.

ABSTRACT

Atmospheric aerosol collected at Universiti Teknologi Malaysia, in Kuala Lumpur, were studied to evaluate the natural and anthropogenic origins of its trace elements for the region. Sixteen Hi-volume air filter samples were collected and analyzed for 25 elements by INAA and AAS. The air filter results show a high variability for certain elemental concentrations over the sampling periods. Enrichment factors of various elements relative to crustal abundances for the air filters indicate that input of the majority of elements is due to crustal weathering or resuspension of soil particulates by the wind. The elements Ag, As, Br, Cd, Co, Ni, Pb, Sb and Zn show very large enrichment in the aerosol relative to the crustal abundances.

INTRODUCTION

The composition and distribution of the natural background and anthropogenic aerosols have been of increasing concern in the last decade. This interest stems from the concern of possible global climatic modification and more importantly possible health effect from atmospheric pollution on man at large.

Trace elements enter the atmosphere from many sources including wind-blown dust, fuel combustion and from many other human activities. Leaded gasoline is thought to be a major source for Pb and Br. Refuse incineration may be an important source of Zn, Cd and Sb[1]. While Al and Si are predominantly found in soil.

The purpose of this study is to describe the level of possible natural and anthropogenic origins trace-elements found in the ambient total suspended particulate (TSP) matter samples collected at one site of Kuala Lumpur. The results were subjected to an enrichment factor and pairwise correlation analysis. This study was hoped to identify those elements which were abnormally enriched in the atmosphere as well as to differentiate sources of these elements.

EXPERIMENTAL METHOD

Sample Collection

Ambient 24-hr average TSP samples were collected every other day from Jan - March 1986. Air sampling was carried out on the roof of a 15 meters - high building in the university campus located 2 km northeast of the city center of Kuala Lumpur. The location of the sampling site is shown in figure 1. The TSP was collected using hi-volume air sampler (SAUV-IH) calibrated at 1.13 m^3/hr. The samples were collected on Whatman-1000 glass fiber filters, conditioned in a controlled room temperature for at least 24-hr before pre - and post-weighing.

Elemental Analysis

Elemental analysis of Al, As, Au, Ba, Br, Ca, Cl, Cr, Dy, Eu, K, La, Na, Sb, Sc, Sm, Ti and V were carried out using intrumental neutron activation analyzer (Triger MK-II). Several 25 cm^2 filter area were cut for the analysis with an average neutron flux of $3x10^{12}$ $n.cm^{-2}$ s^{-1} in the reactor. The irradiated samples were detected by the hyper-pure germanium semi-conductor with the resolution of 1.9 keV at 1332 keV ^{60}Co. The accuracy and precision of the system has been reported.[2]

The elemental Pb, Mn, Cd, Zn, Co, Mg, Cu, Fe, Ag and Ni were determined by AAS. (Perkin Elmer 5000). A portion of the filter area (3.5x17.5 cm), was cut and digested in concentrated HNO_3, H_2SO_4 and diluted with double distilled deionised water. Detail of the sampling and elemental analysis procedures have been presented elsewhere.[3]

RESULTS & DISCUSSION

As many as 18 TSP samples have been collected during the study period. The mean, standard deviation, and ranges of concentration for 25 elements observed in the TSP are shown in Table 1. Copper contamination from the brush wear on the copper commutator of the hi-volume sampler motor is significant[4] and is reflected in this study by high daily copper concentration.

The high standard deviations as well as the large concentration ranges of Al, Ag, Ba, Co and Ni indicated high variability in sample concentration. The variability of the meteorological parameters such as wind speed and wind direction could bring to this effect. This suggests that these elements are associated with localized sources and this was no exception for Al which is predominantly known as soil derived aerosol. Since at any time wind could have blown up the uncovered ground area (as there were constructions around the city area) resulting a wider range between the minimum and the maximum concentration of the element found on the sample filter. While those elements with small standard deviations suggest earth crust, or uniformly distributed source contributions.

Air Particulate Enrichments

A simple method in identifying elements that are enriched in the atmosphere as compared to average crustal material is to calculate an elemental enrichment factor (EF)[1]. This enrichment is calculated by obtaining the ratio of the air concentration of an element normalized to a reference element to the crustal concentration normalized to the same reference element as given below:

$$EF = \frac{[\ X/Al\ ]_{aerosol}}{[\ X/Al\ ]_{crust}}$$

Where X is the concentration of the interest element. For this work, Al has been chosen as the reference element since soil is almost certainly the source for Al. An enrichment factor much greater than one means that a given element is enriched more in the aerosol than in crustal material. The reference crustal concentrations were taken from Wedepohl.[5] The calculated EF for the elements is presented in Figure 2. The lithophilic elements such as Al, Au, Ba, Ca, Cr, Dy, Eu, Fe, La, Mg, Mn, Sc, Sm, Ti and V show relatively low EF values and appear representative of crustal material. Relatively high EF values for Au, Dy and Eu suggest resuspension of mining dust due to mining activities in the area or the soil in the area is rich with these elements. In addition, the presence of local sources cannot be neglected, especially in the case of Cr (EF = 7.4) which is a substantial constituent of metallurgy emission.

The volatile elements such as Ag, As, Br, Cd, Co,Ni, Pb, Sb and Zn show enrichments from 18 to 1543. This indicates the volatile elements are enriched in the atmosphere relative to the crustal abundances. Ag, As, Cd, Co, Ni, Pb and Zn are known to be industrial source chemical species. The As, Cd, Co, Ni and Zn are among the important constituent of combustion related sources. Lead and bromine are mainly produced by combustion of leaded gasoline. Both Pb and Br were well correlated ($r = 0.82$) with each other and were negatively correlated with both Mn and Fe. Both Cd and Zn were positively correlated with Pb and these elements could also be associated with motor-vehicles.[6] Large Ag and Sb EF values are supportive of anthropogenic sources rather than natural soil-weathering processes for these elements. Detail investigation is necessary to as certain the sources of these trace-elements.

CONCLUSION

The concentrations of 25 trace-elements in the air of Kuala Lumpur has been presented. Based on elemental enrichment factor, a soil-derived elements were identified. This include Al, Au, Ba, Ca, Cr, Dy, Eu, Fe, La, Mg, Sc, Sm, Ti and V. An anthropogenic related species include Ag, As, Br, Cd, Co, Ni, Pb, Sb and Zn. Bromine and Lead can be identified with automative exhaust emissions. Subsequently, more detail studies are warranted to verify possible potential sources for the region.

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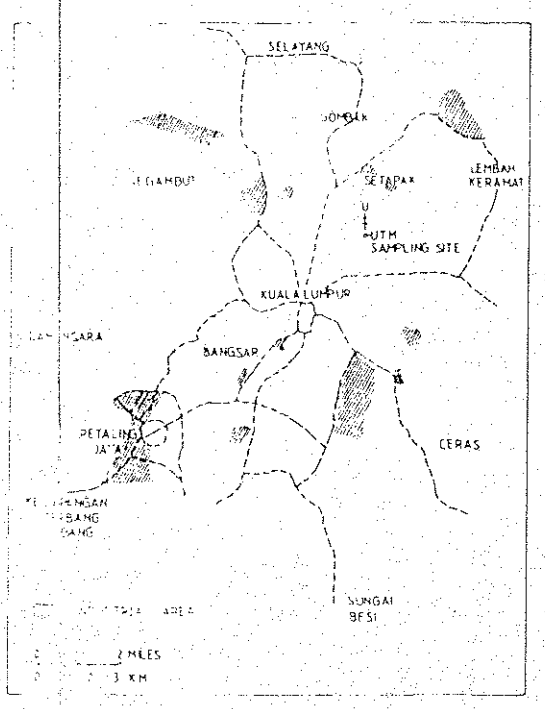
TABLE I : AVERAGE CONCENTRATION OF TRACE-ELEMENT IN THE TSP SAMPLES (PPM)

Element	$\bar{x}$	$\pm\sigma$	Ranges
Al	4.87%	5.86%	981 - 15.4%
Ag	57.8	68.5	3.24 - 186
As	154	57	93.7 - 317
Au	50.9 ppb	28.0 ppb	15.8 - 85.6 ppb
Ba	1067	1181	3.76 - 2431
Br	644	293	142 - 1136
Ca	2.78%	2.01%	0.625 - 6.89%
Cd	12.2	10.6	1.61 - 32.5
Co	488	852	8.43 - 2390
Cr	322	110	226 - 443
Cu+	6531	3225	3098 - 17523
Dy	12.5	7.57	3.25 - 26.10
Eu	12.5	7.74	3.00 - 26.7
Fe	6135	2181	2017 - 11514
La	14.9	8.44	4.54 - 32.5
Mg	3.46%	2.71%	0.35% - 7.59%
Mn	341	176	60.7 - 807
Ni	4825	7164	119 - 13077
Pb	6710	1997	3205 - 10862
Sb	27.1	14.6	6.17 - 60.5
Sc	1.92	0.44	1.54 - 2.74
Sm	1.69	1.46	0.13 - 4.95
Ti	4471	1626	2235 - 6129
V	52.4	25.8	20.4 - 111
Zn	680	150	43.2 - 91.5
TSP Mass*	66.6	15.3	43.2 - 91.5

\+ hi-vol contamination

* Mass in $\mu g/m^3$



LOCATION OF THE SAMPLING SITE

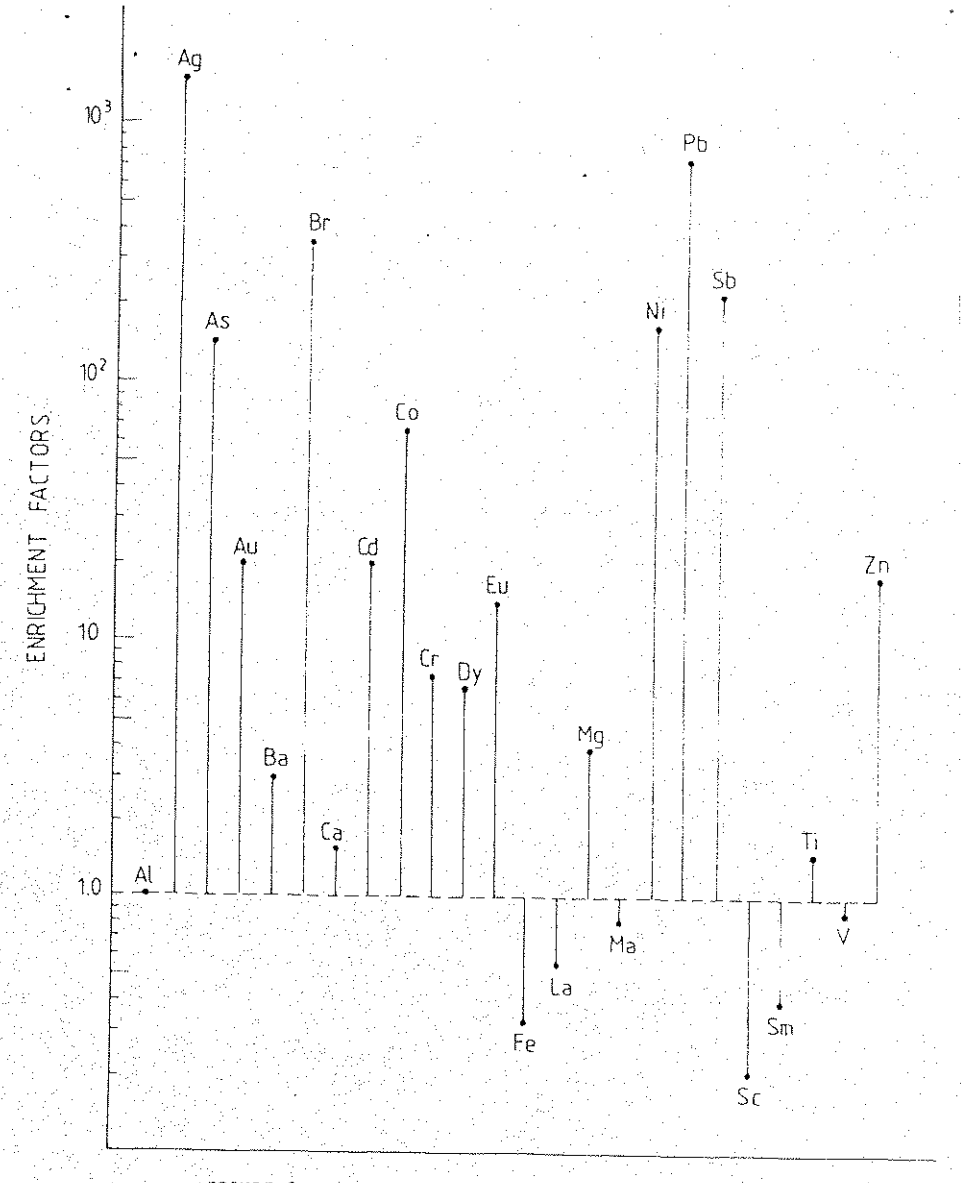


FIGURE 2 : TRACE-ELEMENT ENRICHMENT FACTORS